



# **Project PHAEDRA 2006**

## **21<sup>st</sup> Century technology in the ancient ocean**

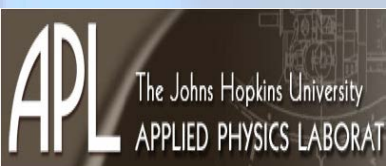
**Justin E. Manley**

**NOAA Office of Ocean Exploration**

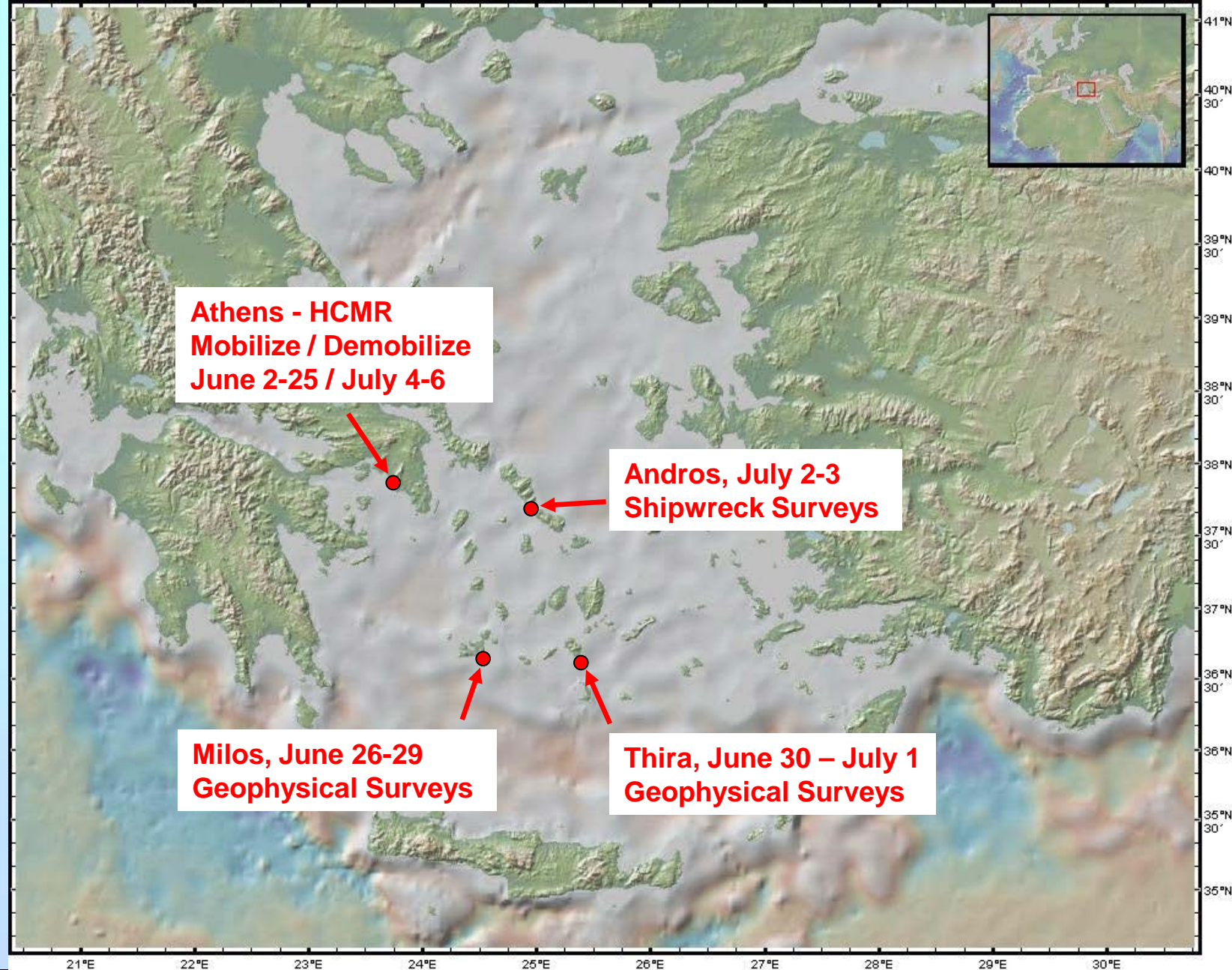
# Project PHAEDRA

- Partnership for Hellenic/American Exploration in the Deep Regions of the Aegean
- Ocean Exploration Signature Expedition
  - NOAA web site coordinator
  - Data manager
- Also a technology development showcase
  - Instruments funded by OE
  - AUVs are of strong interest to NOAA

# A Diverse Team



- Hellenic Centre for Marine Research
- Euphorate of Underwater Antiquities
- Woods Hole Oceanographic Institution
- Olin College
- Johns Hopkins University
- Massachusetts institute of Technology
- NOAA

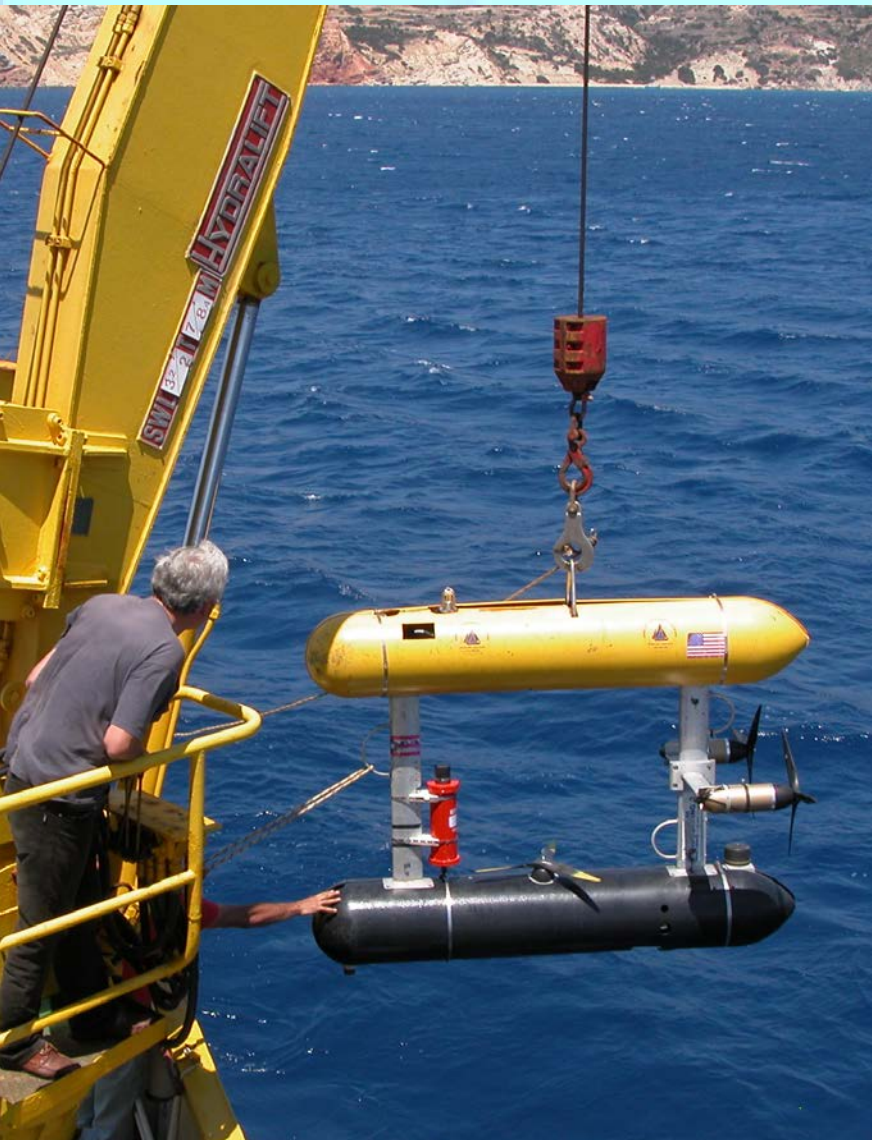




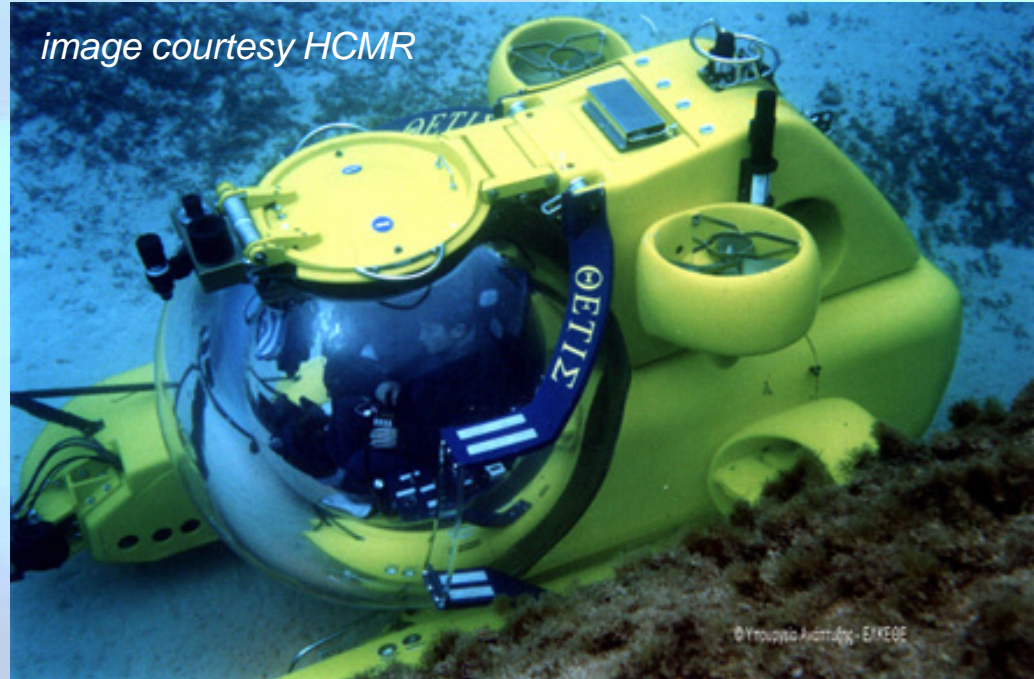
# R/V Aegaeo



# Undersea Systems



*image courtesy HCMR*



HCMR 2-person submersible, Thetis

WHOI AUV, SeaBED



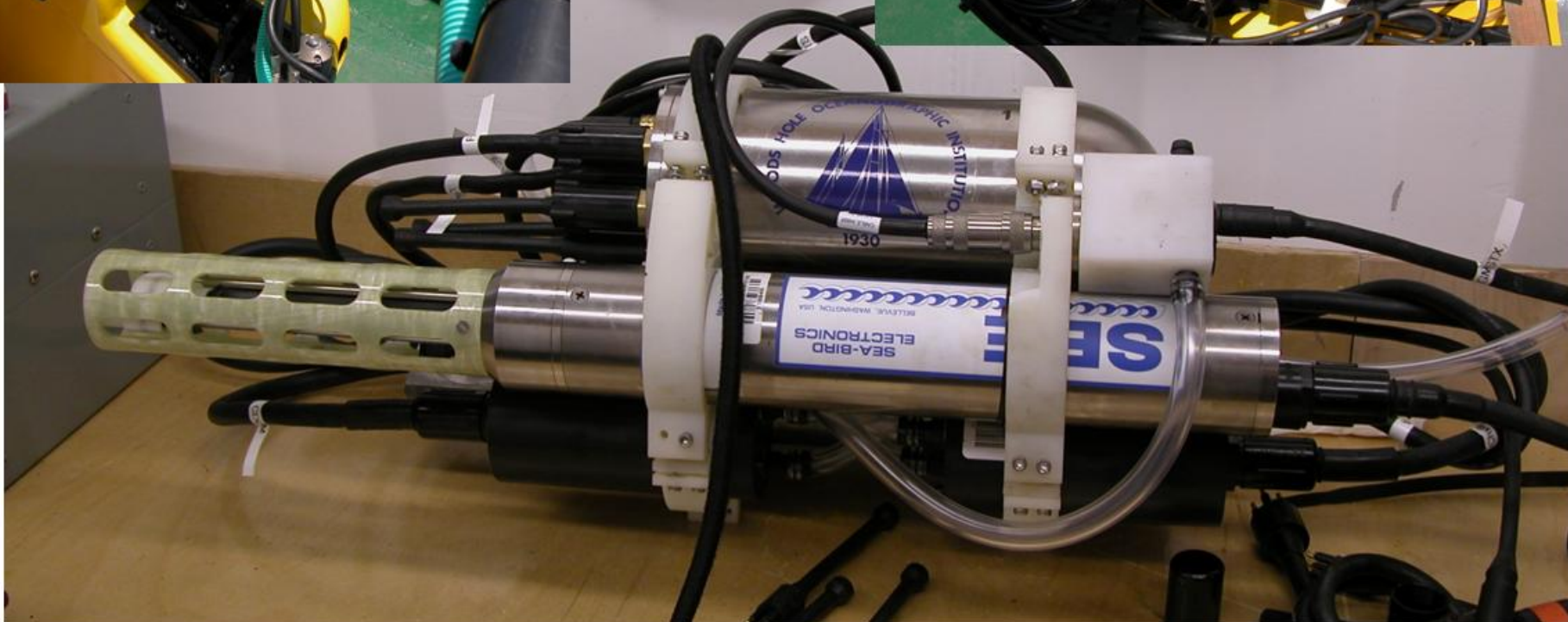
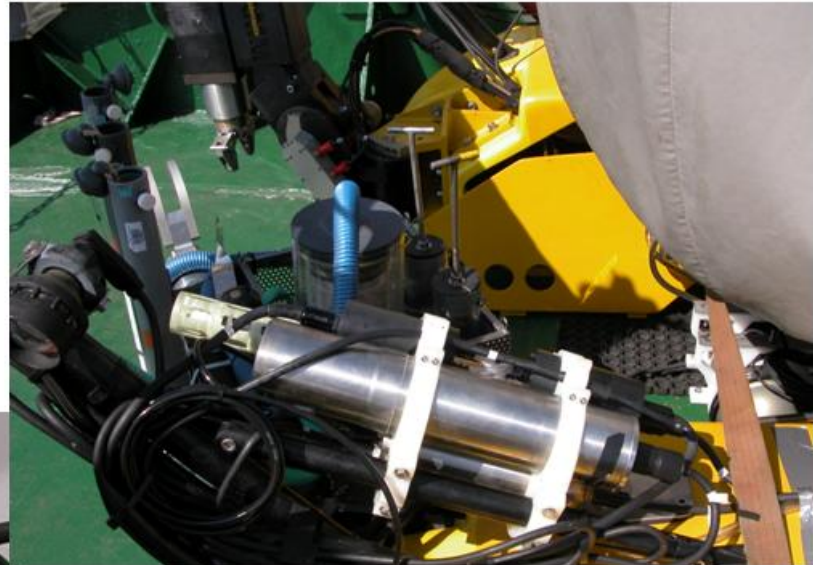
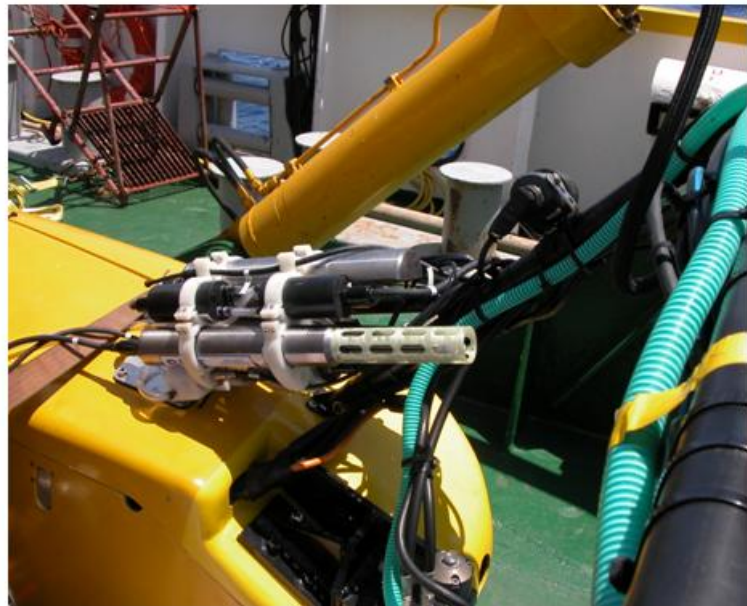
# New Instrumentation on Thetis

*in situ* mass-spectrometer,  
*Gemini*, for dissolved gasses  
and isotopes





Sonde array:  
CTD, D.O.  
fluorimeters,





# Sampling

- Niskin Bottles
  - Ground truth mass-spec
- “Slurp gun”
  - Collect biological samples
- Push cores
  - Collect sediment samples

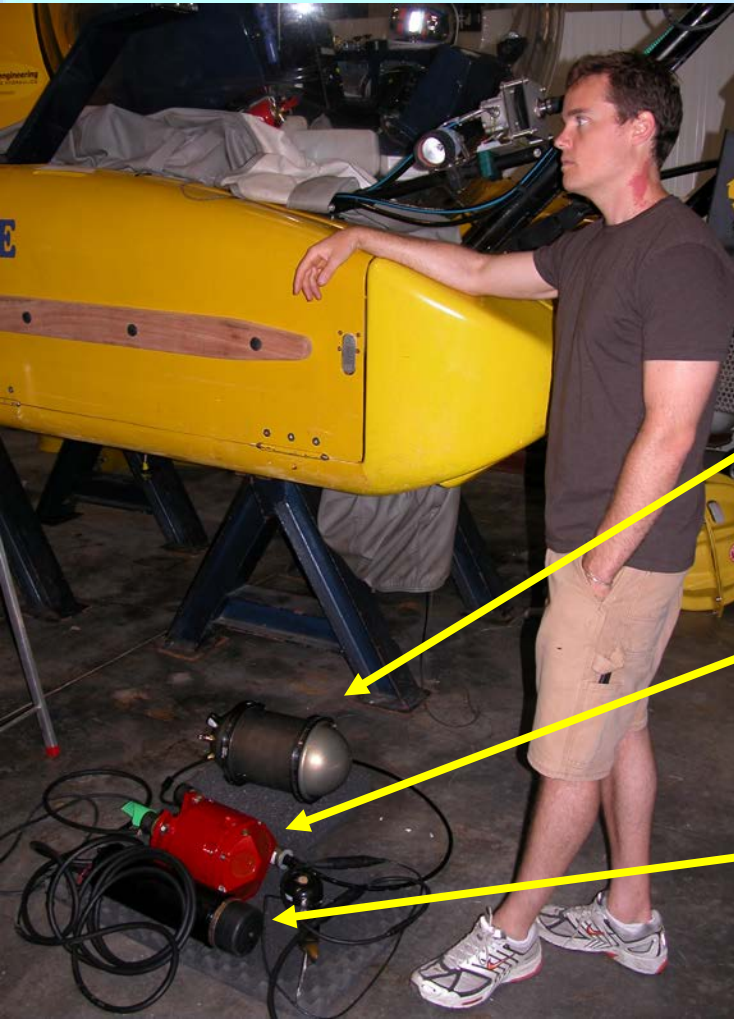


Ship/Lab Based processing  
To ground truth *Gemini* data





# Precision Navigation



Long Baseline (LBL)  
acoustic transponders

Precise timing to GPS  
PPS signal

Doppler Velocity Log

Acoustic modem for  
one-way travel time



# Transponders are logistically expensive



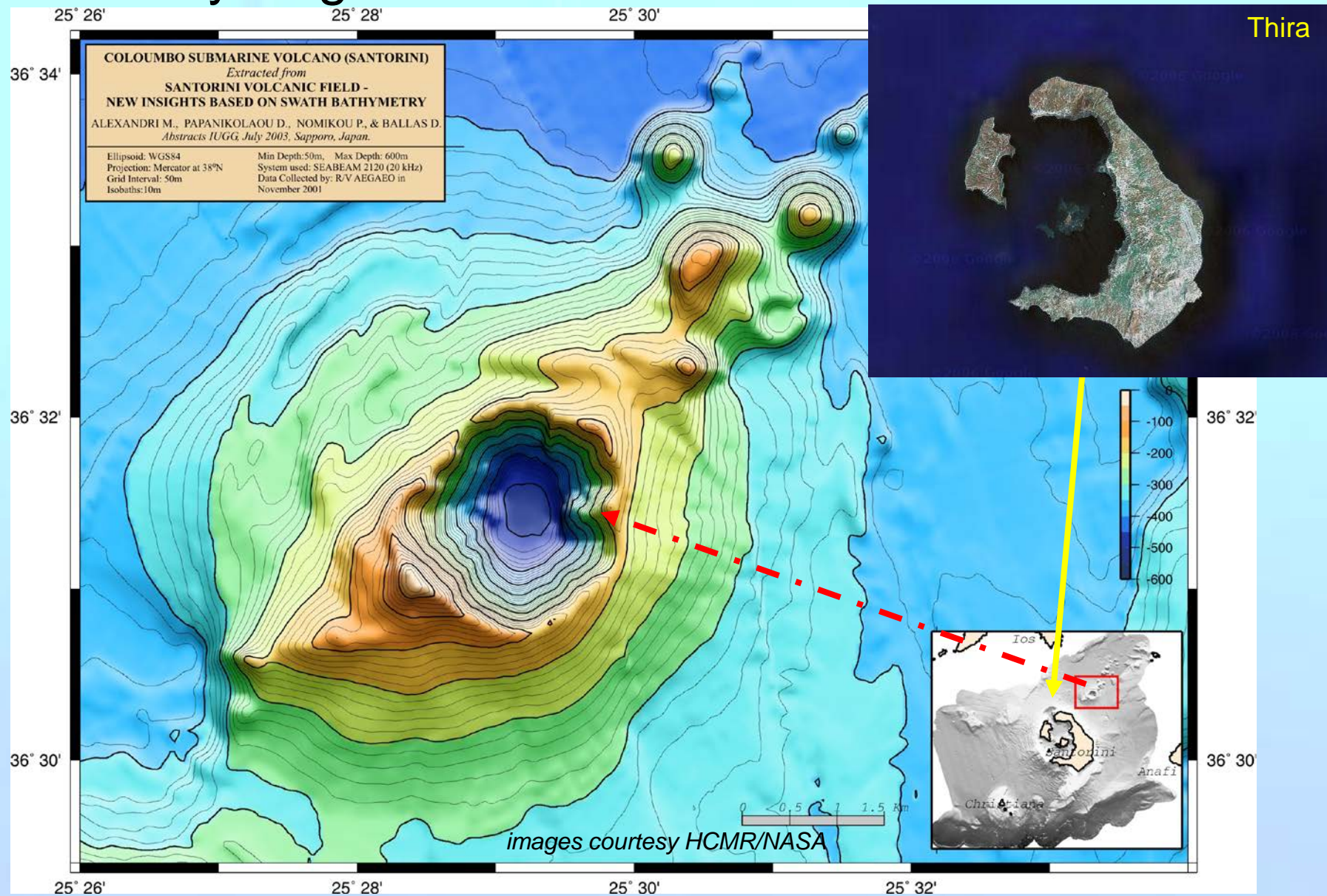
*image courtesy Matt Grund, WHOI*



# Technology Enables Science

- Oceanography
  - Geochemistry of volcanic seabed regions
- Archaeology
  - Ancient wrecks in the “sea of Odysseus”
- Exploration methodology
  - Comparative data sets help distinguish wrecks from rocks
  - Rapid mapping techniques allow those data sets to become statistically meaningful
  - In situ sensors allow rapid evolution of science mission

# Many Aegean islands are extinct volcanoes





Geology  
everywhere!







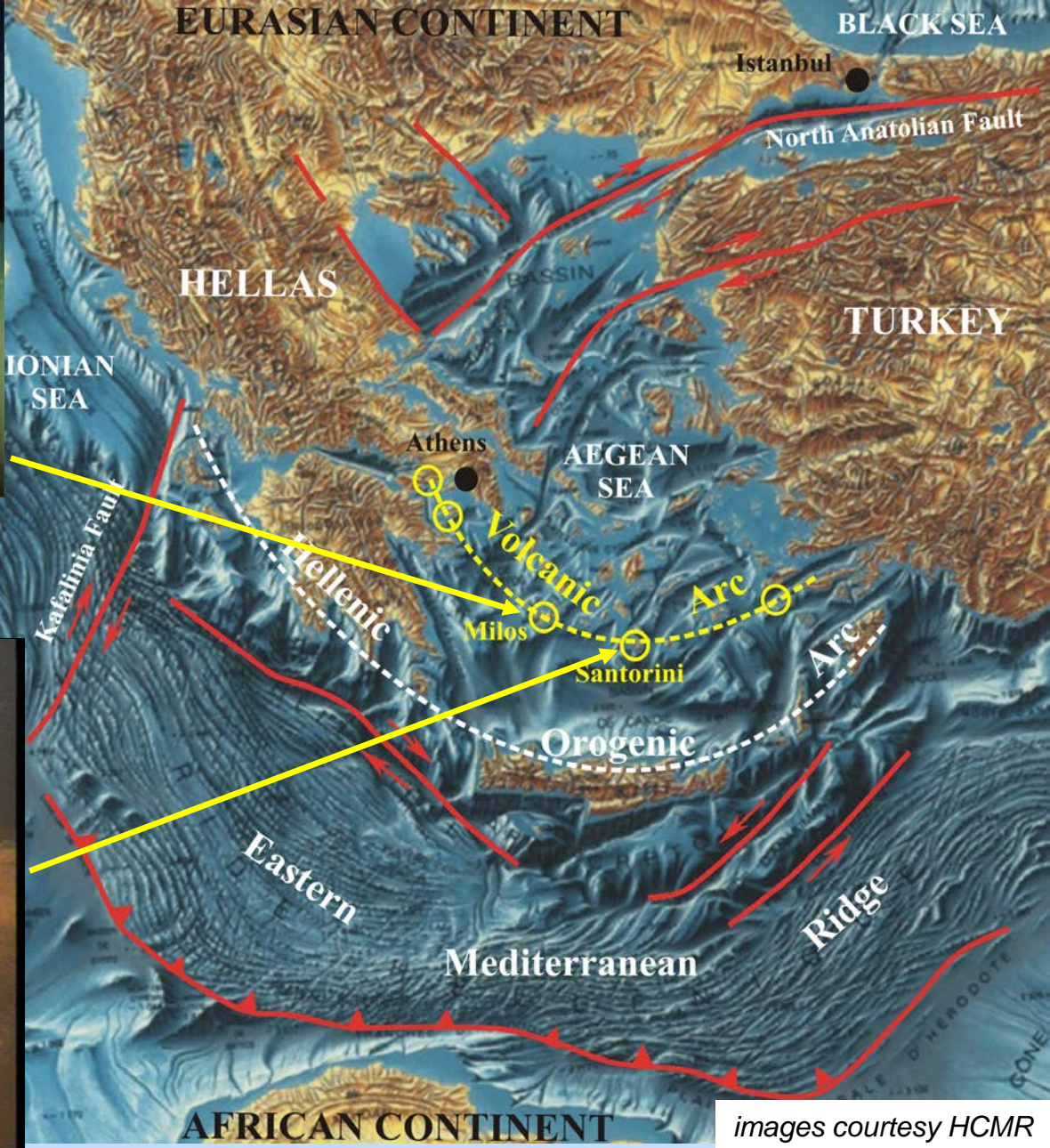




HOV view of Milos site &  
ROV view of Thira site

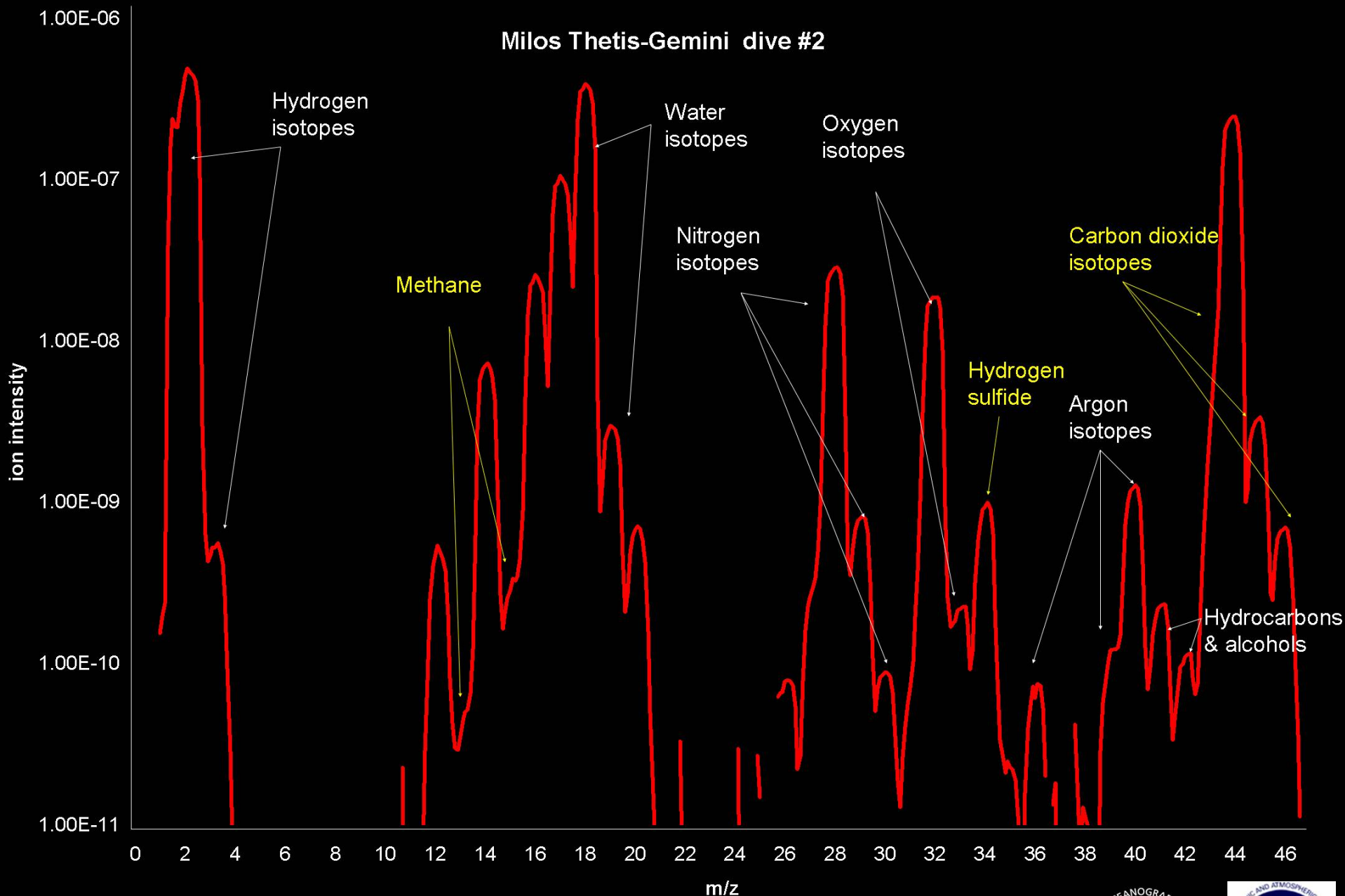


↓082 P339 C246 A00.8



images courtesy HCMR

# Milos Thetis-Gemini dive #2

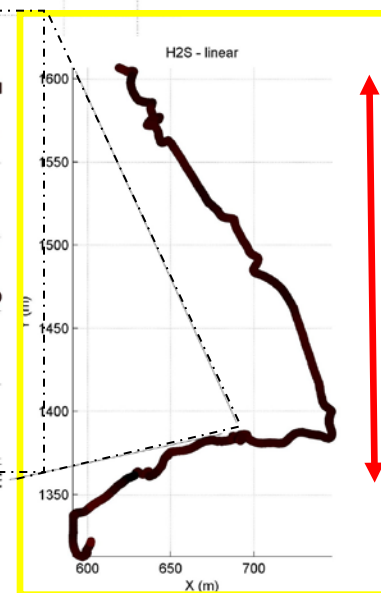
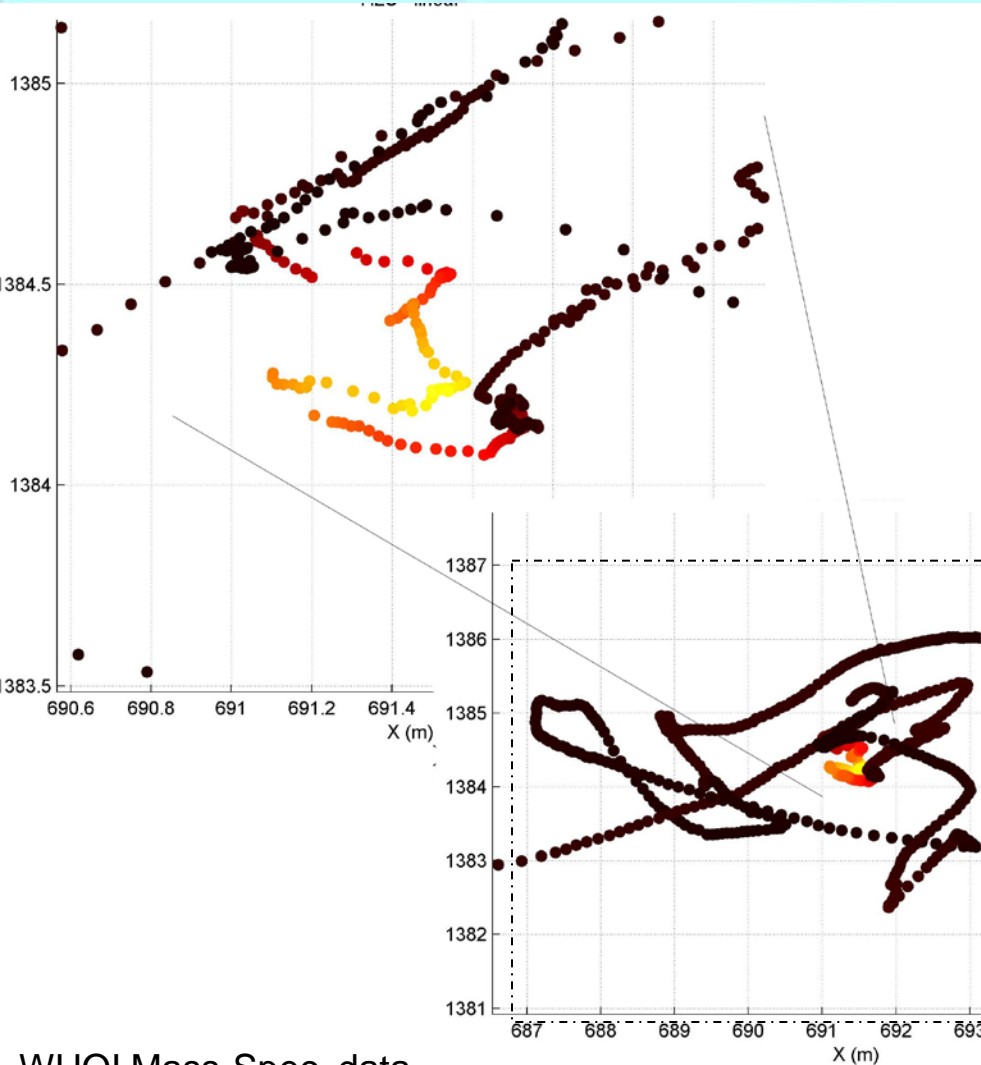


Richard Camilli  
WHOI Deep Submergence Laboratory



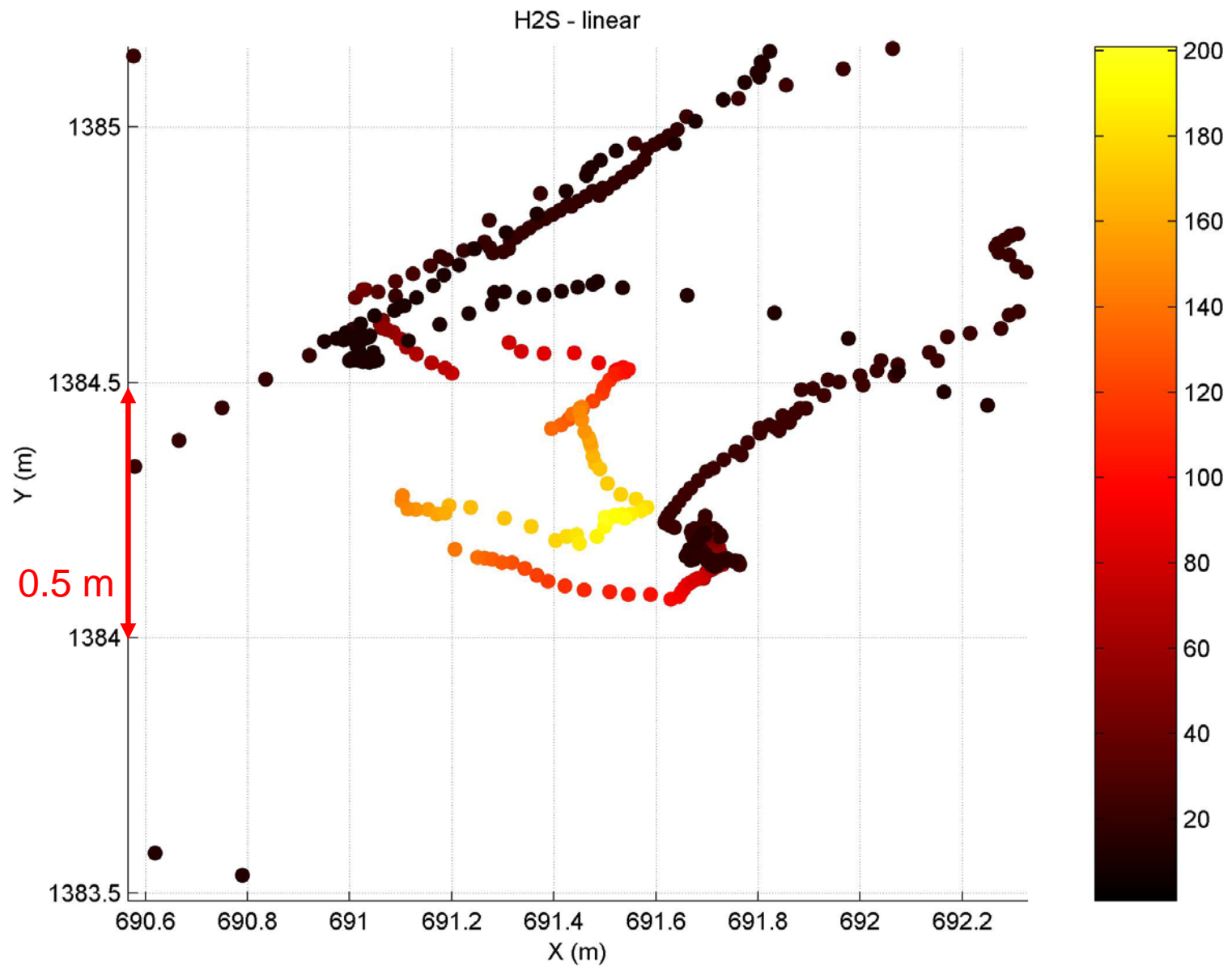


# A question of scale



WHOI Mass-Spec. data,  
Hydrogen Sulfide Concentration

data plots courtesy WHOI/Olin College





# Technology (instrument & navigation) enabled:

- Discovery of cold seeps “undiscoverable” by other means
- Verification (negative data) of vent/seep activity within Milos caldera
- “Discovery” of non-chemically active region (thought to be vents) in Thira caldera
- Chemical “mapping” of Andros shipwreck

# Shipwreck Survey



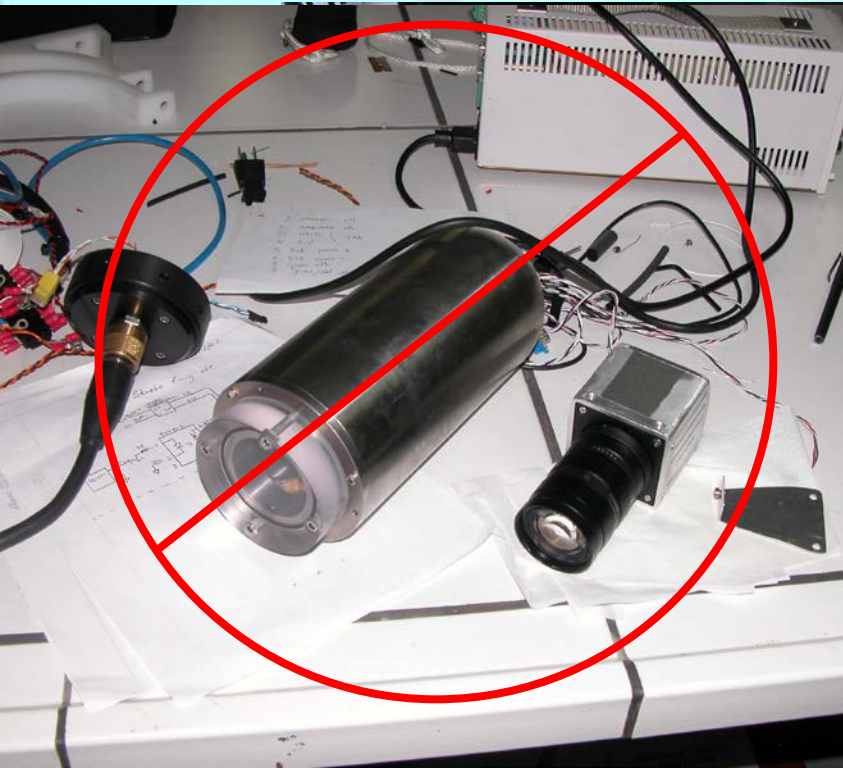
- Limited ship time due to permit delays
- Weathered out of ancient site at Kythnos
- Backup site at Andros was “occupied”
- What to do?



# 1) Clear the site

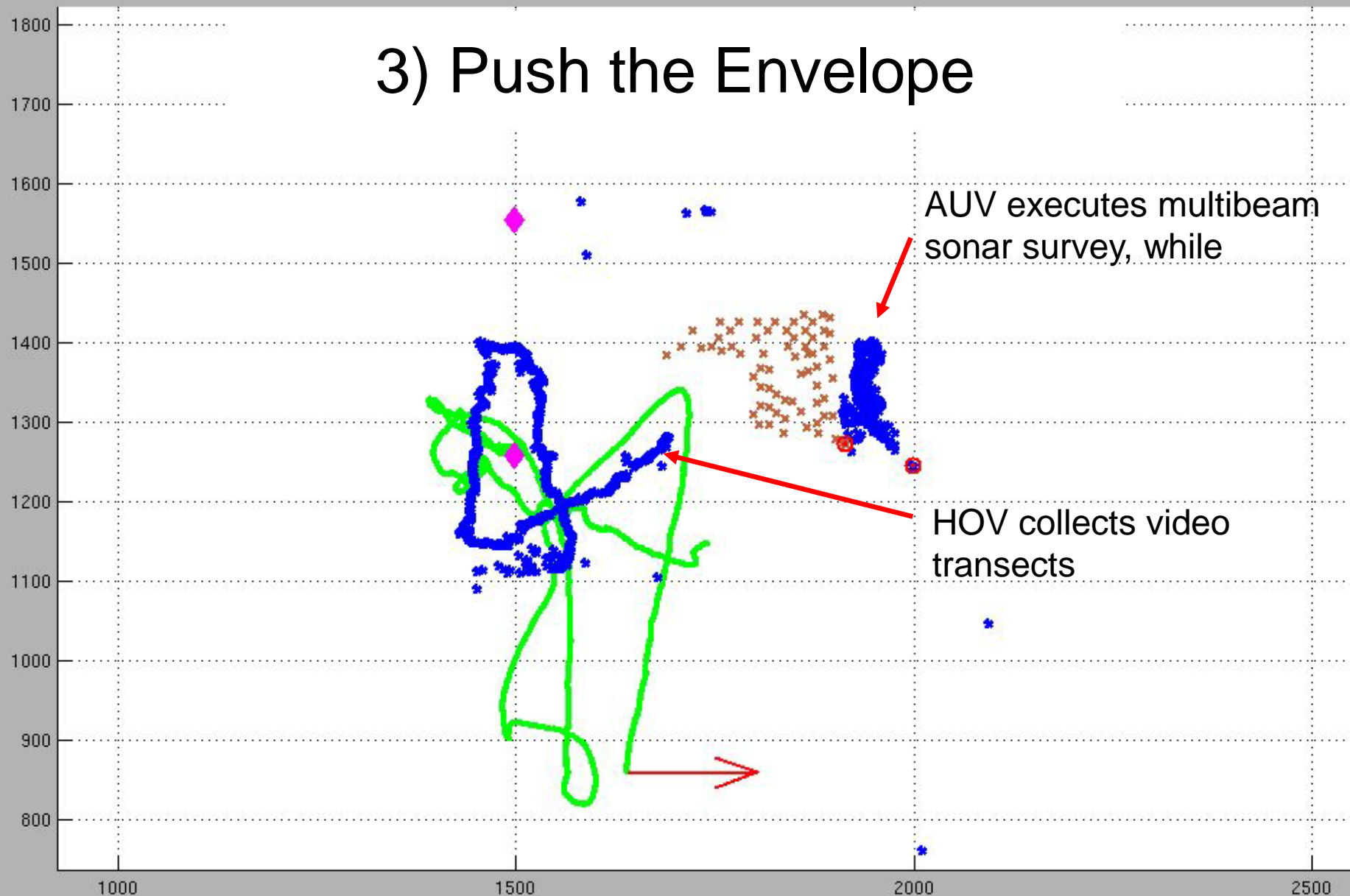


## 2) Improvise





### 3) Push the Envelope



# First Known Combined HOV/AUV Survey



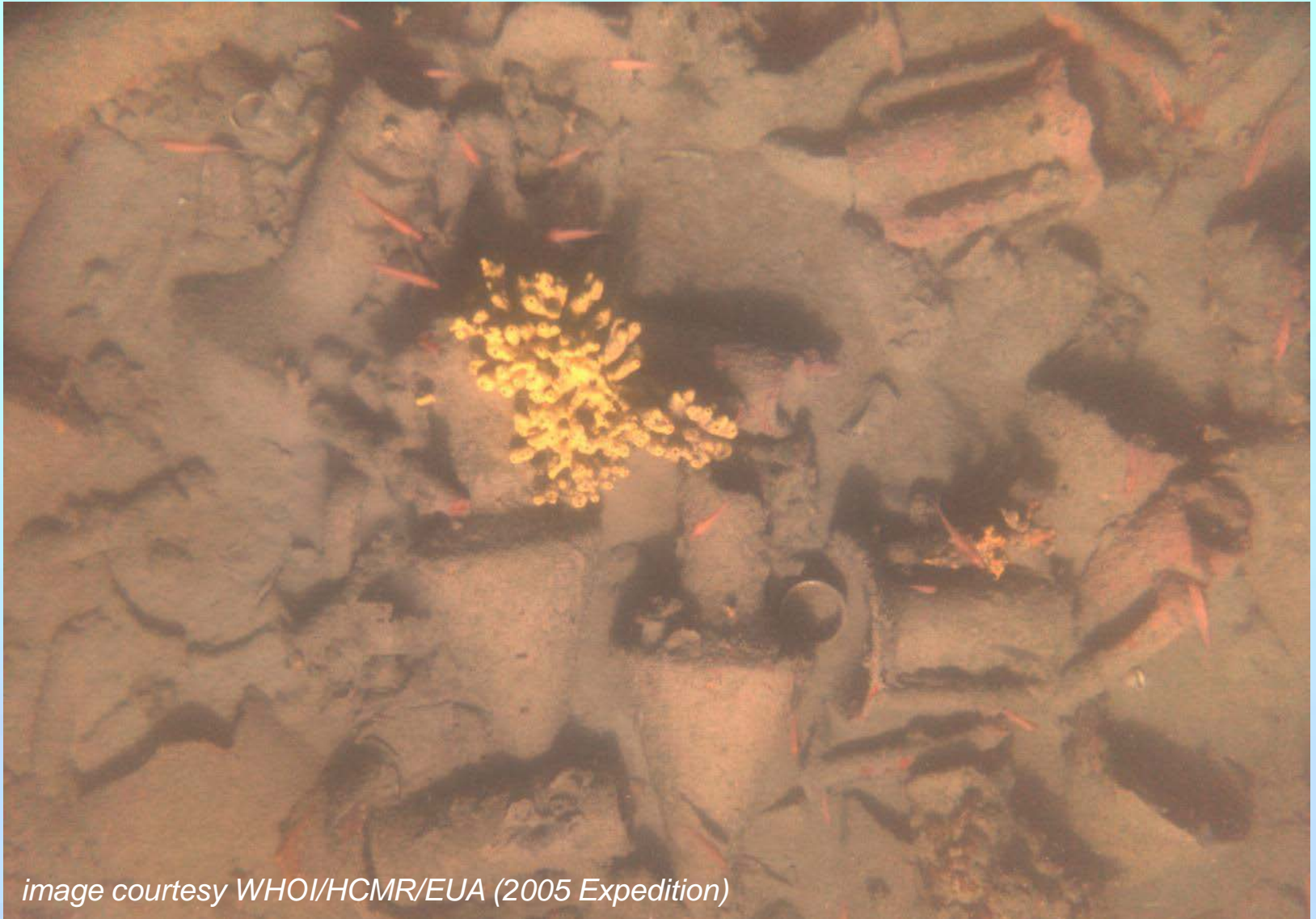
- Two complete video surveys (HOV)
- One chemical survey/map (HOV)
- Two multibeam sonar surveys (AUV)
- All in less than 18 hours!



# What is it good for?

- Currently no data products from 2006 available
  - Processing underway
  - Greek Ministry of Culture restricts release of images and data
- 2005 results
  - Integrated camera/sonar on AUV
  - Ancient wreck
  - But lacking chemical survey data

# Ancient shipwreck becomes modern habitat

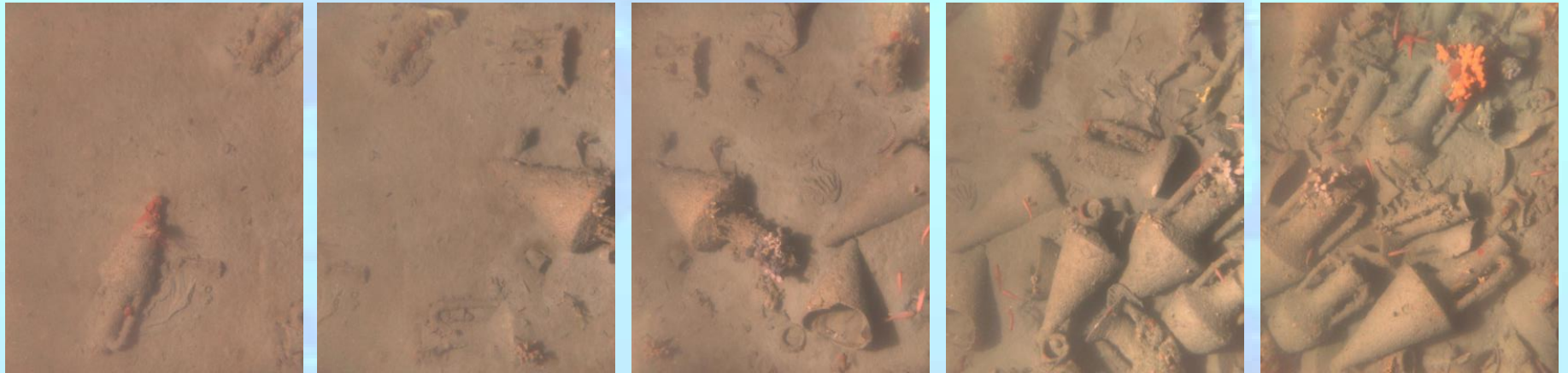


*image courtesy WHOI/HCMR/EUA (2005 Expedition)*



# Multiple images provide context

1) Individual images collected by SeaBED every 3 seconds

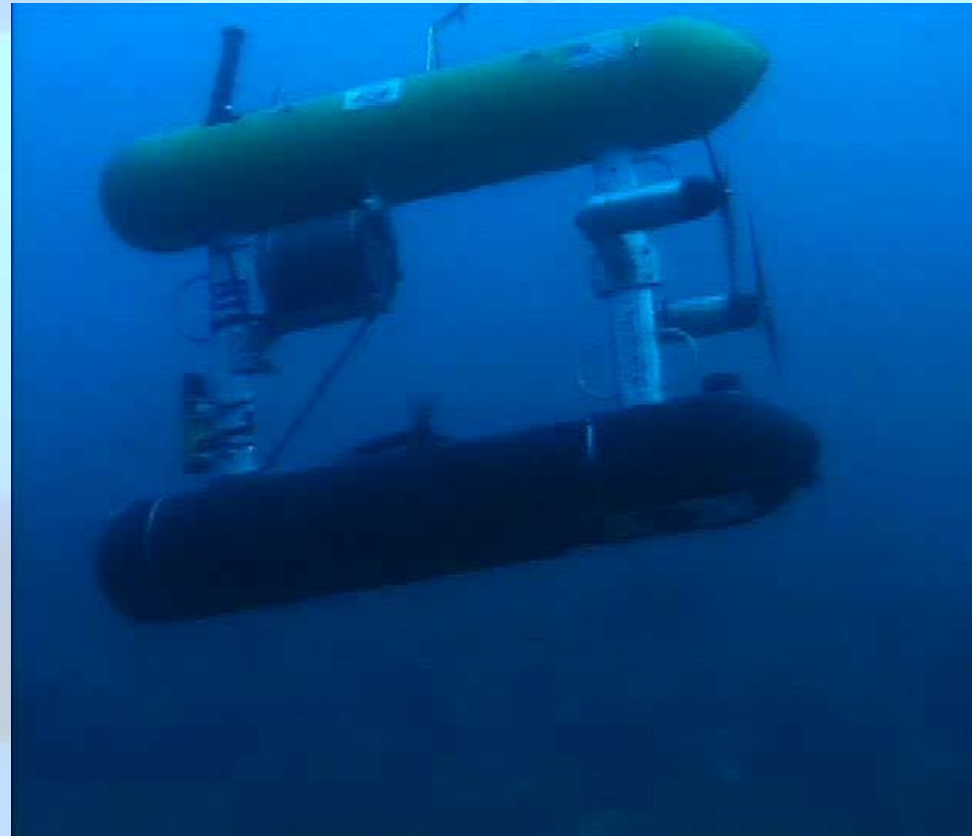
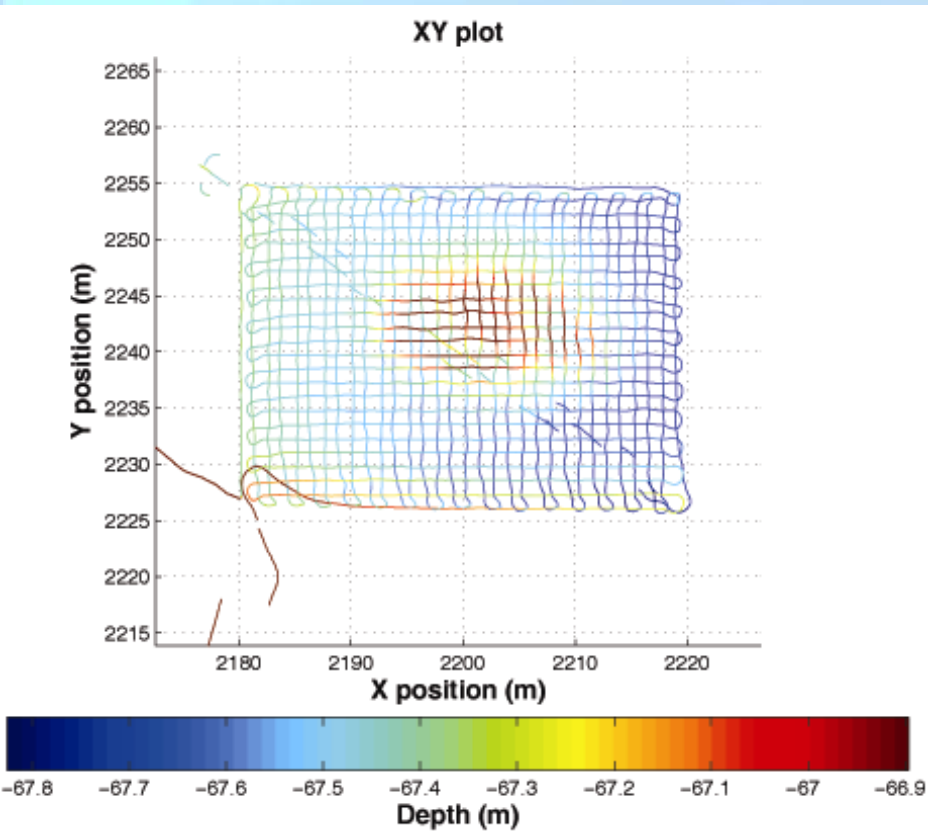


2) later assembled into photomosaic strips with automated software



*images courtesy WHOI/HCMR/EUA (2005 Expedition)*

# Precision Navigation and Control are Critical

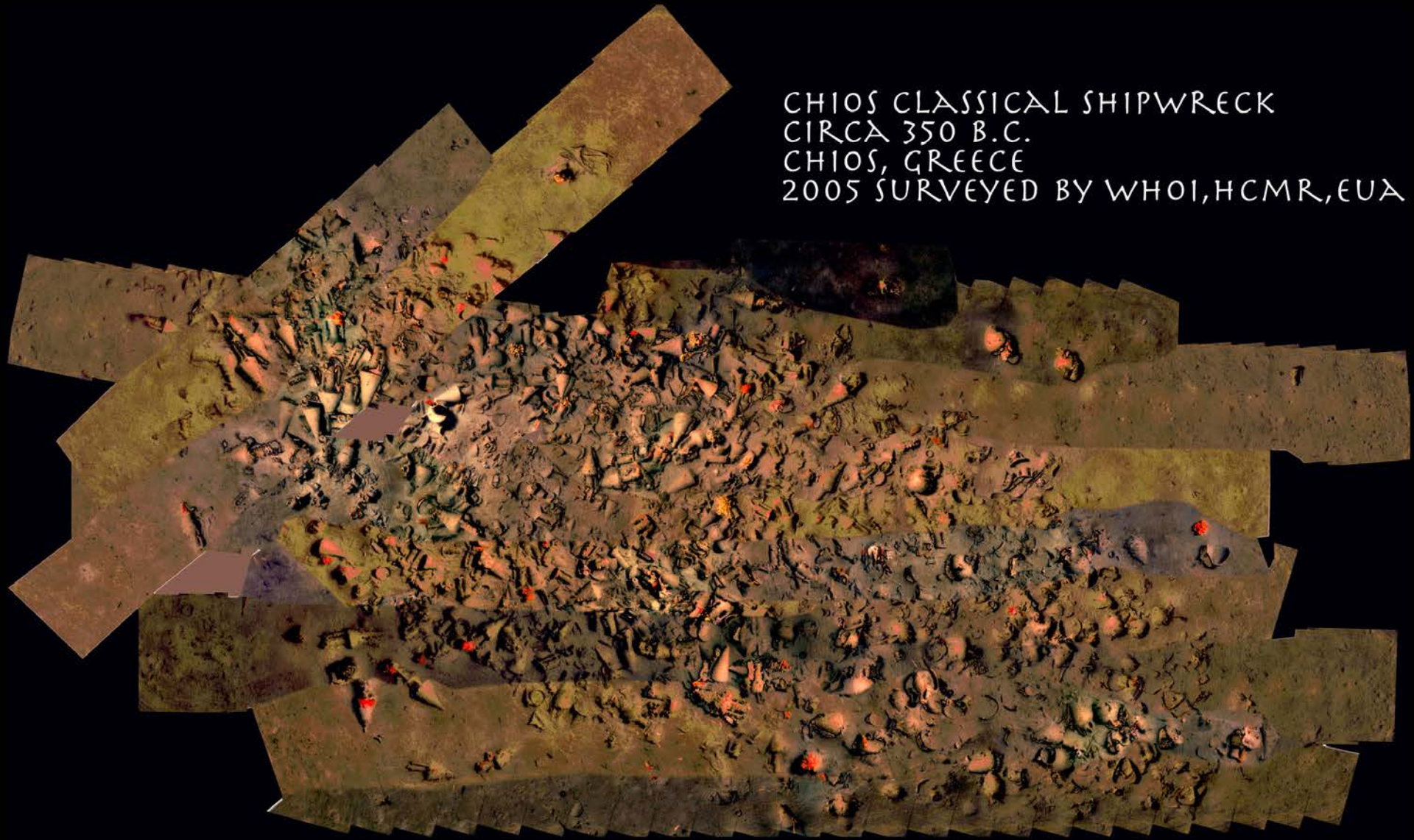


*images courtesy WHOI/HCMR/EUA (2005 Expedition)*



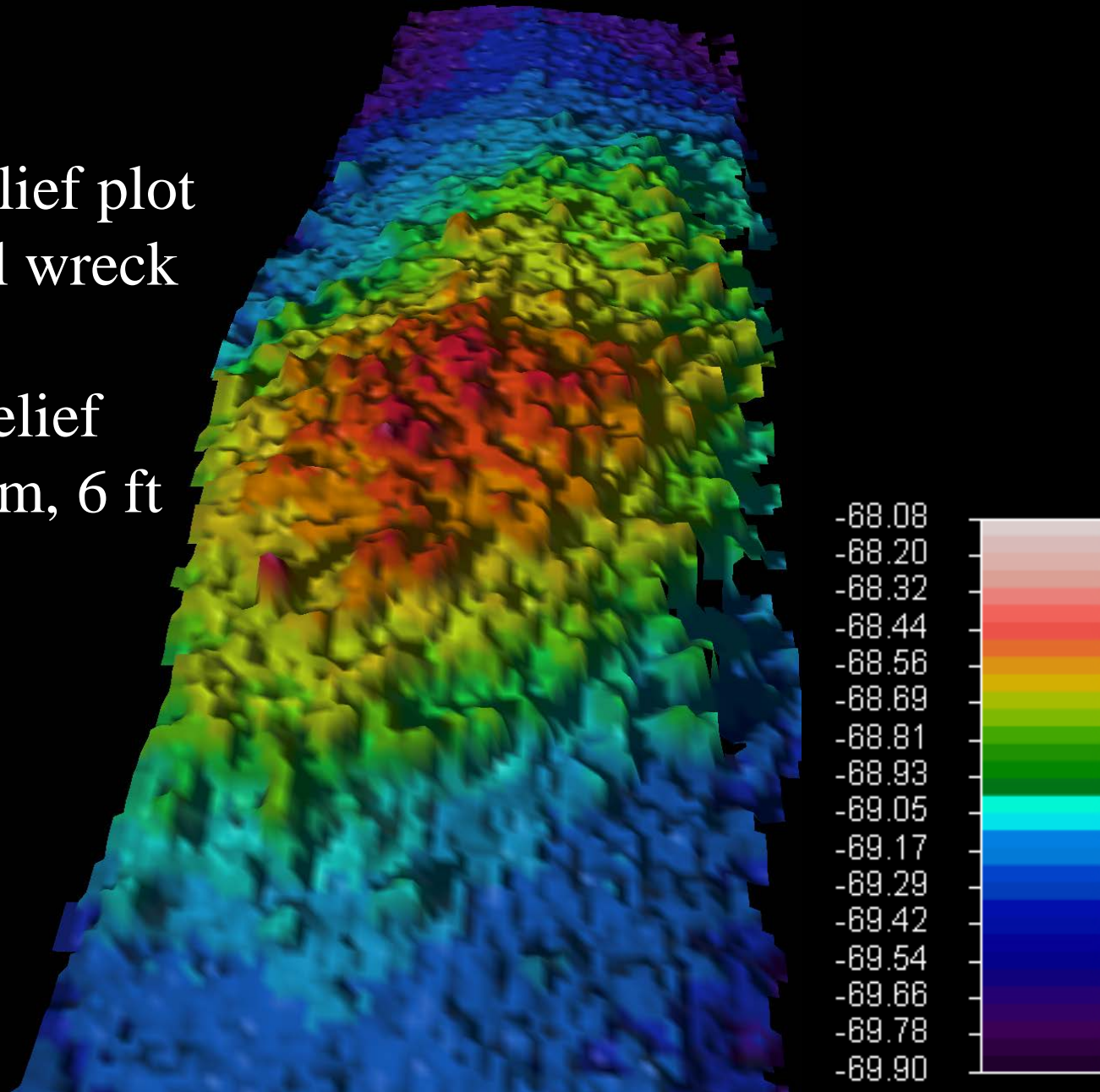
# Results are impressive

CHIOS CLASSICAL SHIPWRECK  
CIRCA 350 B.C.  
CHIOS, GREECE  
2005 SURVEYED BY WHOI, HCMR, EUA



# Contour and relief plot Chios Classical wreck

Total vertical relief  
over site = 1.8 m, 6 ft



courtesy WHOI/HCMR/EUA  
(2005 Expedition)





Two-dimensional mosaic  
draped over microbathymetry

Total vertical relief:  
 $1.8 \text{ m} = 6 \text{ ft}$

*courtesy WHOI/HCMR/EUA  
(2005 Expedition)*

# Next Steps

- Combine all three technologies
  - In situ chemical sensing
  - Multibeam survey
  - Photomosaics
- Refine the one-way-travel time navigation
- Perfect the data product (and create new ones)
- Rinse and repeat
  - Collect new statistical data on wrecks distributed across the Mediterranean Sea
  - Apply to global oceanographic subjects as well



# Beyond Ocean Exploration

- Environmental monitoring
  - Habitat maps combining bathymetry and in situ oceanographic data (backed up by QA/QC via traditional methods)
- Offshore oil
  - Dissolved gas sensing is possible in situ
    - Reduced time to leak detection/repair
    - Improved prospecting
- Defense/Homeland Security
  - Unexploded ordinance detection
  - Improvised marine IEDs
  - Narcotics

# Questions

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